METABOLIC CYCLES AND THE FLIGHT OF VESPINE WASPS

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It has long been noted by the author that the temperatures of excavated colonies of *Vespula* (s.str.) and the earth immediately around these colonies are higher than those of the air or the earth at some distance from the nest. Since this temperature differential has been attributed to metabolic heat, it was believed that a similar phenomenon must occur among colonies of the arboreal *Dolichovespula* species. In order to determine if this might be true, two colonies of *D. maculata* L. were established near a window of a laboratory in Windsor, Mass. Laboratory thermometers were thrust through the paper envelope of the nest in such fashion that the bulbs of the thermometers were located between layers of brood comb. Check thermometers were placed in the air six inches from the nests.

Within two days the ergates had repaired the damage done to the nest envelope by the penetrating thermometers, and had effectively sealed these instruments into the nests. At this point data were collected.

It is common knowledge that an aggregate of living cells will produce detectable quantities of metabolic heat. That this is true among insects has been shown by Mosebach-Pukowski (2) and others, who noted that gregarious lepidopterous larvæ can raise their own temperature by one or two degrees when they gather. It is accordingly not astonishing that Vespine colonies, comprising numbers of larvæ (with a relatively high metabolic rate due to feeding and growth), pupæ (with a relatively low metabolic rate) and adults of the several castes, all of which are confined within a number of layers of paper envelope (an excellent heat insulator) generate and retain appreciable quantities of metabolic heat.

Air temperatures and internal nest temperatures were noted for a full 24 hour period at regular hourly intervals. Subsequent temperature readings were made for a number of hours at a time, at different periods of day and night. These subse-

quent readings confirmed the accuracy of the first observations. It was at once realized that absolute readings of temperature were worthless in an understanding of the problem. Variations in air temperature were far greater than differences in nest temperature. Therefore a system of relative temperatures was devised, in which the air temperature at any one reading was subtracted from the nest temperature, giving the temperature differences. It is apparent that the nest temperature would vary with the air temperature, while the difference between the two, if a positive number, would represent heat from metabolic activity.

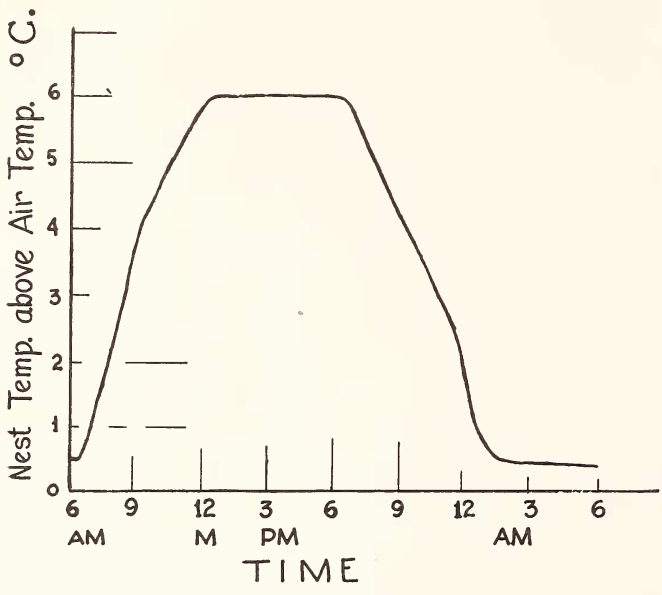

Figure 1. Daily Cycle of Metabolic Temperature Change in a Nest of *Dolichovespula maculata* Linn.

By considering air temperature a constant, and plotting nest temperature difference against time, Figure 1 is the result.

Both colonies of *D. maculata* under observation were of nearly the same size (9 inch diameter) and both had a population of from 65 to 70 ergates, with a probable brood of 90, discounting eggs. The temperature differential curves for the two nests were remarkably similar.

There is a nocturnal constant of 0.5° C. above the surrounding air. This is a fair indication of the normal resting metabolism of the colony. Immediately after the morning flights begin, the temperature differential begins to rise above the 0.5° minimum. The attainment of 6.0° C. above the surrounding air occurs about noon and continues until the colony settles down for the night. This morning increase is probably the result of several factors. When morning flights start, fresh food is brought in by the foragers. Work is performed in the nest as other ergates (brood nurses) distribute food to the larvæ. Work is done by the larvæ in metabolizing the food. Also the absolute temperature is increasing outside from the sun's heat, and may perhaps be increasing the efficiency of Vespine enzymes which would accelerate metabolism.

The relatively slow temperature differential drop at night indicates a more gradual slackening in metabolic activity. This slackening could well be correlated to the more gradual decrease in evening air temperatures, and hence the gradual decrease in enzyme efficiency. Of course, from the moment the light drops below the threshold for flight no more food supplies are imported, and the decrease in temperature difference can in part be accounted for in decrease in food metabolism. It is the author's opinion that both factors are present and interactive both in morning and evening. This cyclical production of heat is perhaps akin to Lammert's cycles of heat production in the hives of the honeybee during winter months.

Total heat production is not represented on the graph, as there are certainly substantial heat losses through the nest envelope, and through wing fanning within the nest. Also much potential colonial heat is lost by the ergates in the field.

It is remarkable that the flight activities as determined by the author (1) correlate so completely with the metabolic rate as determined by heat production. Whereas flight is initiated by certain threshold minima before the wing muscles can function at the proper frequency, the temperature of the colony depends in turn upon the quantity of food brought into the nest by the flight muscles. The increase in the daily temperature differential is nearly simultaneous with the awakening of the colony.

The moment of temperature decline is nearly coincident with the cessation of the day's flight activity.

In conclusion, it can be stated that there is a definite daily metabolic cycle of heat production in the Vespine nest. This metabolic cycle is closely coincident with the daily activity cycle. The heat production is probably dependent upon the importation of food to the nest, and to the influence of the actual heat upon enzyme activity which in turn increases the metabolic rate of the wasps.

REFERENCES

1—GAUL, A. T. Awakening and Diurnal Flight Activities of the Vespine Wasps. (In Press)

2—MOSEBACH-PUKOWSKI, E. 1937. Temperatures in Larval Colonies. Z. Morph. Oekol. Tiere. 33: 358–380.

INTERNATIONAL UNION FOR THE STUDY OF SOCIAL INSECTS

At the 1951 meeting of the International Entomological Congress in Amsterdam, it was decided to organize an International Union for the study of social insects. The aims of the union are: (1) to foster the scientific study of problems concerning these insects and (2) to integrate such work in appropriate ways internationally and within the various countries.

Dr. T. C. Schneirla, of the American Museum of Natural History, New York 24, N. Y., has been named Chairman pro tem and Dr. Chas. D. Michener, Dept. of Entomology, University of Kansas, Lawrence, Kansas, is secretary pro tem of the North American section.

It is planned to establish a Bulletin, which would contain news items, lists of current publications and other reports of work in progress, as well as discussions and short articles of interest. A trial number, prepared and financed by the French section will appear shortly.

Entomologists, who would be interested in becoming affiliated with the North American section of the union, are asked to write to either Dr. Michener or Dr. Schneirla, so that they might be informed of further developments, and receive the initial copy of the Bulletin.—F. A. S.